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REGULAR ARTICLES

Welfare evaluation of dairy cows reared in the East of Algeria

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Abstract
The aim of the study was to evaluate the welfare status of dairy cows raised in local conditions through health criteria. Important health problems have been identified as well as their effect on the milk yield. One hundred seven farms in eastern Algeria were visited. Data on health, productivity, and management practices were collected. Clinical examination of 1210 dairy cows was conducted to assess health scores. The relationship between herd health and milk yield was investigated using multiple linear regression models. The average milk yield per cow was 16.1 kg/day, and the average prevalence of thin cows (body condition score ≤ 2) was 35.1%. The cow dirtiness was a sign of poor facility hygiene, with 24.3% of cows had dirty udders, 44.5% had dirty flanks/upper legs, and 59.6% had dirty hind legs. The mean prevalence of clinical lameness (locomotion score ≥ 3) and severe lameness (locomotion score ≥ 4) were 24.7% and 8.7%, respectively. The prevalence of hocks, knees, and neck injuries (score > 1) with wound and/or swelling ranged from 0 to 46.2%, 0 to 71.4%, and 0 to 14.3%, respectively. The clinical examination showed a percentage of cows with mastitis of 15.4%, diarrhea of 6.9%, cough of 3.2%, nasal discharge of 7.5%, and ocular discharge of 1.8%. Thus, the milk yield had associated with severe lameness, mastitis, thinness, and dystocia. In conclusion, the welfare indicators in this study reflect the serious health problems in dairy farming which influence the expression of the cow genetic potential.

Keywords Algeria · Dairy cattle · Milk yield · Health · Welfare

Introduction

Over time, the moral status of animals has evolved considerably in Western societies (Nussbaum, 2006). The topic of animal welfare has received increasing attention in recent decades and debates are pervasive in the media (Veissier and Miele, 2015; Mounier, 2021). In response to societal expectations, many developed countries have protected animal welfare through legislation such as Prevention of Cruelty to Farm Animals Act in the USA and Council Directive 2008/119/EC in EU, which set species-specific minimum standards specific to each species. Broom (1986) defined animal welfare as the ability to maintain physical and mental stability to react successfully to a difficult situation. So, poor welfare is an extension of the inability to cope, which can lead to health problems. The World Organization for Animal Health considers adequate animal welfare to require disease prevention and veterinary care for injuries and illnesses, sufficient comfort, proper nutrition, and humane slaughter in decent conditions (WOAH, 2023).

To assess overall animal welfare, it is necessary to take a combination of measures, including animal-based measures such as cleanliness, lameness, and body injuries which are more useful than resource-based measures for evaluating the true animal conditions (De Vries et al., 2011). Most authors consider health as an essential part of animal welfare (Hughes 1976; Dawkins, 2006), and health indicators can provide important information on the animal conditions. On the other hand, zootechnical criteria have a great place in animal welfare evaluation, and weaker production performance compared to the genetic potential of the animals are possible indicators of discomfort (Lensink and Leruste, 2012).

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Welfare assessment on dairy farms is rarely considered in Algeria (Benatallah et al., 2015). To contribute to a better knowledge of this concept, a survey was conducted in an important dairy region of Algeria to study the welfare of dairy cows, emphasizing the major health issues.

Materials and methods

Description of the study area

The survey was conducted between October 2020 and March 2021 on 107 dairy cow farms in the Souk-Ahras region, located in the east of Algeria with an area of 311,000 ha. Two types of climate are predominant in the study area: a sub-humid climate in the north with an average precipitation of 700 mm/year, and a semi-arid climate in the south with a precipitation of 250 mm/year. This area is characterized by a hot and dry summer and a cold and wet winter. The temperature averages 33 °C in summer and 12°C in winter.

Farm and studied animals

Sampling was carried out on the basis of lists provided by the agricultural services in the province of Souk-Ahras. Those lists contain 955 dairy farmers. A preliminary list of 336 farms was generated at random while adhering to certain criteria: number of cows (≥ 6), main breed (Montbeliard), and ease of accessibility. Their farmers were contacted by phone to explain briefly the objective of the study. Only 132 farmers accepted willingly to participate; thus, they were visited once, starting after morning milking. Twenty-five farms were eliminated for missing and/or unreliable data. The final sample selected for analysis included 107 farms.

Welfare and management measures were quantitative variables represented on different scales and collected by the same assessor. The farm was considered a sampling unit.

To ensure highly applicable findings and statistically reliable results, we have identified a standard sample of farms that adequately represents the survey's scope. We followed the methodology outlined by Thompson (2012) to determine the optimal random sample size.

$$n = \frac{N \times p(1-p)}{[N-1 \times \left(d^2 + z^2\right] + p(1-p)]}$$

Knowing that the reduced deviation corresponds to a confidence level of 95%.

The sampling error = 5%, with N = population size.

The main used breed was the Montbéliarde (81.3%), along with other breeds such as Holstein (8.6%), Fleckvieh (3.2%), and Brown Swiss (2.7%). Montbéliarde cows are imported from France and used mainly for milk production. They are very hardy and easily adapt to the conditions of any climate, including the Algerian climate.

Measurements and scoring

The evaluation of animal welfare was based on a set of health measures, complementary to each other. In the studied farms, 1210 (85.2%) cows were scored individually by direct observation, of which 76% were lactating, 24% were dry cows, and 63% of cows were pregnant.

On farms with more than 20 cows, at least 15 cows were chosen at random, in farms with 13–20 cows, at least 10 cows were chosen, and in farms with 12 or fewer cows, all were examined.

The body condition score (BCS) was measured for each observed animal according to the system developed by Vasseur et al. (2013). The scale ranged from 1 to 5 for very thin and very fat cows, respectively. Injuries on dairy cows were scored at the neck, hock, and knee according to the method proposed by Gibbons et al. (2012). The hock and knee conditions were assessed based on the tarsal and carpal joints on a 4-point scale. The neck injuries represented by the dorsal portion between the back of the ear and the top of the shoulder were scored on a 3-point scale. The cleanliness of the hind legs, udder, and upper leg/flank was noted on a scale ranging from 1 (clean) to 4 (very dirty) according to guidelines reported by Cook (2009). For each area, dirtiness was calculated as the percentage of cows with a score higher than 2. The locomotion score was assessed by walking the cows in a straight line on a hard, non-slippery surface on which they would normally walk. A five-point scale was used with scores ≥ 3 for clinical lameness and scores of 4 and 5 for severe lameness (Thomsen et al., 2008). Hoof evaluation on the basis of the shape and size of the hind and anterior claws was scored 0 for normal hooves and 1 for abnormal hooves (Brule et al., 2007).

The clinical examination of the cows' health status was carried out to detect the presence of diseases and symptoms such as mastitis, coughing, pica, diarrhea, and nasal, ocular, and vulvar discharges. Clinical mastitis was described as an inflammation of the udder and alterations in the consistency and color of the milk (Pinzón-Sánchez and Ruegg, 2011). The finding of persistent cough was recorded during the visit. The licking of materials, walls, skins, and/or suckling congeners was considered evidence of pica. Diarrhea and nasal, ocular, and vulvar discharges in the cows were visually assessed and recorded according to the Welfare Quality® assessment protocol (Welfare Quality®, 2009).

The livestock manager was asked about the incidence of dystocia and downer cows in the last 12 months preceding the visit. Farm records were also used. Milk yield, lactation length, dry period, and pasture access were collected from farmers and available data records.

Herd size (number of cows): Herd size refers to the total number of dairy cows present on the farm at the moment of the visit.
Daily milk yield (kg/day): Daily milk yield is the amount of milk produced by an individual cow in kilograms within a 24-h period.
Lactation period length (days): The lactation period length is the duration during which a dairy cow produces milk following calving. It is defined by the time between calving and the dry-off before the next calving.
Dry period length (days): The dry period is the period when a dairy cow is not producing milk, usually occurring between two lactation periods.
Pasture (days per year): Pasture refers to the amount of time dairy cows are allowed to graze on pasture during the year.
Parity (average lactations): Parity refers to the number of times a cow has calved and completed a lactation.

Statistical analysis

Analyses were performed by IBM SPSS V 26.0. A descriptive analysis of the data was reported as medians, means, minimum and maximum values, and standard deviation (SD) of different variables. To determine associations within and across animal health indicators, Spearman rank correlations were calculated because several variables were not normally distributed according to the Shapiro–Wilk test. A stepwise multiple linear regression model was estimated to investigate the relationship between average daily milk production per cow, and the following predictors: clinical and severe lameness, thin cows, knee and hock injuries, abnormal claws, cleanliness of body regions, nasal discharge, cough, diarrhea, mastitis, dystocia, and downer cow. These variables were pre-selected because they were potentially associated with dairy cow productivity. Independent variables were assessed for multicollinearity (correlation coefficients > 0.65), and if two variables were highly correlated with each other, the one with the plausible biological relationship with the dependent variable was chosen for inclusion in the multivariable model. The residuals were normally distributed ($P = 0.2$) by the Kolmogorov–Smirnov test. Only predictors with a P-value below 0.10 were retained in the final model.

Results

Studied population

A total of 107 farms were visited. The herds contained 1425 dairy cows with an average of 13 ± 9 cows per farm (min 6 and max 67 heads), an average daily milk production of 16.1 kg, and an average parity of 3.2 (min 1 and max 6.4). The cows were milked twice a day with an average interval of 11 h (from 8 to 13 h). The farms used tied housing systems, for a few hours during the day, the cows graze or are in exercise areas.

The majority of buildings have been existed for several years (from 1 to 20 years), with only 16.8% of buildings in good conditions. The others are in a more or less degraded condition. Eighty-six percent of farmers ($n = 92$) declared removing manure with a manual scraper at least twice a day and once a day for the remaining 14% ($n = 15$). Ventilation, which is static in all farms, allows good air circulation in 33.6%, sufficient in 38.4%, and poor in 28% of farms. Depending on the case, the insufficient number of building openings, their small size, their poor distribution, or the low height under the roof were the causes of this poor ventilation.

Livestock feed is based on the purchase of industrial concentrate and dry fodder as well as grazing on several types of pastures (natural grassland, stubble, fallows, forests, and maquis). The average used agricultural area (UAA) is 19.3 ha, and the average cultivated fodder area is 5.86 ha. Various types of fodder were cultivated, mainly barley, alfalfa, vetch, and oats. The herds of the visited farms spent an average of 226.6 days per year on pasture (90 to 350 days) and an average of 6 h per day. Of herds, 34.6% ($n = 37$) spent 300 days per year; however, 39.2% spent less than 210 days per year.

Tables 1 and 2 give descriptive statistics of dairy farm characteristics and welfare indicators related to animals' health.

Dairy cows health and welfare indicators

Locomotion

The average percentages of clinically and severely lame cows were 24.7% and 8.7%, respectively. There are 13 farms (12.1%) without lame cows (clinical or severe). Clinical lameness was positively correlated with severe lameness ($r = 0.730$; $P < 0.0001$). Regarding hoof conformation, the majority (more than 85%) were of normal length. As well as 9.4% of the cows presented anomalies in the posterior hooves, and 12% in the anterior hooves. The results

Table 1 Descriptive statistics of herd information and managements on 107 dairy farms in eastern Algeria

Collected data	Median	Mean	SD	Min	Max
Herd size (no. of cows)	11	13	9	6	67
Daily milk yield (kg/day)	16.5	16.1	3.8	9.3	27.6
Lactation period length (day)	314.5	319.2	35	259	426
Dry period length (day)	61	59.6	18.9	0	91
Pasture (day /year)	220	226.6	59.3	90	350
Parity (average lactations)	3.1	3.2	1.2	1	6.4

Table 2 Descriptive statistics of health measures on 107 dairy farms in eastern Algeria

Collected data	Median	Mean	SD	Min	Max
Clinical lameness (%)	25	24.7	15.8	0	62.5
Severe lameness (%)	7.7	8.7	9.4	0	33.3
Dirty udder (%)	22.2	24.3	18.3	0	71.4
Dirty flank/upper legs (%)	41.7	44.5	20.4	0	100
Dirty hind legs (%)	60	59.6	20	14.3	100
Lean cows (%)	32.1	35.1	26.3	0	100
Hock injuries (%)	16.7	19.6	10.7	0	46.2
Knee injuries (%)	30	32.9	16.1	0	71.4
Neck injuries (%)	0	1.4	3.6	0	14.3
Abnormal posterior hooves (%)	7.1	9.4	10.9	0	33.3
Abnormal anterior hooves (%)	11.1	12	12.1	0	57.1
Nasal discharge (%)	5.3	7.5	8.9	0	45.5
Ocular discharge (%)	0	1.8	4.3	0	22.2
Cough (%)	0	3.2	5.4	0	27.3
Diarrhea (%)	0	6.9	10.4	0	50
Vulvar discharge (%)	0	0.9	3.1	0	12.5
Mastitis (%)	14.3	15.4	12	0	42.9
Pica (%)	0	1.4	3.5	0	12.5
Dystocia (%)	9.1	9	6.8	0	28.6
Downer cow (%)	4.5	5.5	5.9	0	20

demonstrated that there is a positive and significant correlation ($r = 0.490$; $P < 0.0001$) between the posterior and anterior hooves abnormalities. Likewise, severe lameness was correlated with abnormal anterior claws ($r = 0.548$; $P < 0.0001$) and abnormal posterior claws ($r = 0.644$; $P < 0.0001$).

Injuries

The proportion of dairy cows with knee injuries varied considerably between herds, from 0 to 71.4% of cows. Fifteen herds (14%) had less than 15% of cows with lesions, while 22 herds (20.6%) had more than 45% of cows with lesions. The mean prevalence of cows with hock injuries was 19.6% (0 to 46.2%) and was positively correlated with knee injuries ($r = 0.779$; $P < 0.0001$). On the other hand, only 1.4% of cows had neck injuries.

Body condition

The average prevalence of lean cows (BCS ≤ 2 on grid of 0 to 5) was 35.1% (0 to 100%). Of the herds, 37.4% ($n = 40$) had less than 25% lean cows, and 25.2% ($n = 27$) had more than 50%. Only 13.1% ($n = 14$) of visited exploitation had no lean cow, while 21.5% ($n = 23$) of them had between 60 and 100%.

Cleanliness

The cleanliness of the cows varied according to the studied area of the body. Only 24.3% of udders are considered dirty (note ≥ 3) in all farms. Conversely, 59.6% and 44.5% of hind legs and upper leg/flank were dirty, respectively. Cleanliness of the upper leg/flank area was positively correlated with that of the udder and hind leg ($r > 0.64$; $P < 0.0001$).

Diseases and symptoms

Clinical examination showed a mean prevalence of animals with clinical mastitis of 15.4%, diarrhea 6.9%, cough 3.2%, pica 1.4%, nasal discharge 7.5%, ocular discharge 1.8%, and vulvar discharge 0.9%. Clinical mastitis was significantly correlated with diarrhea ($P < 0.0001$), cough ($P < 0.05$), pica ($P < 0.05$), nasal discharge ($P < 0.0001$), ocular discharge ($P < 0.001$), and vulvar discharge ($P < 0.05$). During the 12 months preceding the visit, the farms presented on average 9.1% dystocia and 5.5% downer cows from a totality of 1681 cows. These last variables were significantly correlated ($P < 0.01$).

Milk yield and its affecting factors

The average daily milk yield per lactating cow was 16.1 kg/day (from 9.3 to 27.6 kg/day), and only 14% ($n = 15$) of the herds produced more than 20 kg/cow/day. The average lactation length varied from 259 to 426 days with a mean of 319.2 days, and the dry period varied from 0 to 91 days with an average of 59.6 days. It was generally less than 65 days, before the presumed date of calving, in 70.1% of the herds. In 4.7% of herds only, the drying up was not practiced.

The stepwise regression of milk production against welfare-related indicators of cows' health, yielded associations with the proportion of mastitis ($P < 0.0001$), severe lameness ($P = 0.082$), thin cows ($P < 0.0001$) dystocia ($P < 0.01$) and abnormal anterior hooves ($P = 0.088$). Farms with high milk yield had fewer lean cows, less mastitis, and lameness. The model explained 72% of the variance (Table 3).

Discussion

The present study aims to evaluate dairy cattle welfare in Algerian dairy farms according to the level of some provided resources (inputs), production management practices, and animal-based observations and measurements (outcomes). Using a combination of inputs and outcome indicators is the best approach to measuring animal welfare (WOAH, 2023). The obtained results provide reliable tools for dairy cattle functioning assessment and also for consultancy to make cow welfare and productivity more acceptable.

Table 3 Final model of multivariable linear regressions for health factors related to milk yield in 107 dairy farms in eastern Algeria ($R^2 = 0.723$, R^2 ajusted = 0.706)

Factors	Estimate [1]	S.E [2]	t [3]	P-value	95.0% CI [4]
(Constant)	21.033	0.436	48.235	< 0.0001	20.168, 21.898
Severe lameness	− 0.065	0.037	− 1.758	0.082	− 0.139, − 0.008
Mastitis	− 0.116	0.025	− 4.637	< 0.0001	− 0.166, − 0.066
Thin cows	− 0.074	0.009	− 8.266	< 0.0001	− 0.092, − 0.056
Dystocia	− 0.100	0.034	− 2.972	< 0.01	− 0.167, − 0.033
Abnormal anterior hooves	0.034	0.020	1.723	0.088	− 0.005, 0.074

[1]Regression coefficient; [2]standard error; [3]value of the t-statistic used to calculate p-values; [4]confidence interval

Lameness

Whay et al. (2003) recognized lameness as the major welfare problem facing European dairy farms. However, farmers tend to underestimate the situation of lameness in their herds (wells et al., 1993). In the studied farms, the prevalence of lameness (24.7%) was close to that observed in the UK (22%, Whay et al., 2003) and Canada (21%, Solano et al., 2015), while our result was lower than that reported in the UK (31.6%, Griffiths et al., 2018).

Regarding severe lameness, it had a prevalence of 8.7%, within the range of 6 to 10% reported in previous studies (Von Keyserlingk et al., 2012; Chapinal et al., 2013). Clinical and severe lameness were positively correlated to one another, which corroborated with a previous study (King et al., 2016). Hock injuries such as hair loss and swelling were correlated with lameness, which was confirmed by Whay et al. (2003).

Hock, knee, and neck injuries

Tarsal and carpal joints are the most parts of the body which exposed to high pressure, especially while lying down. Therefore, they are frequently used to exanimate body injuries and the quality of management practices. In our study, the prevalence of hock lesions was lower than in other previous studies, where it was 39.3% (Jewell et al., 2019). However, it was close to 16.3% observed by Rutherford et al. (2009). Injuries to the Tarsal joint were characterized by hair loss spots with lesions and/or swelling. These injuries appear when the cow is lying on abrasive floor with poor hygiene (Gibbons et al., 2012). There are few studies on carpal joint injury; however, a prevalence of 35% was reported by Kielland et al. (2009). This is slightly higher than our result. The prevalence of neck injury was lower than the reported 4.7% in Canada by Jewell et al. (2019).

Body condition

The prevalence of lean cows in the current study was similar to the average prevalence of 33.1% (Benatallah et al., 2015) but higher than the result of Boyer des Roches (2012), who observed a percentage of 16.3% lean cows. In the literature, the different surveys carried out on dairy farms have also highlighted wide variations between farms. Nevertheless, the variability reported in the literature remains moderate in comparison with ours. Main et al. (2003) reported that the percentage of lean cows ranged from 5.6 to 30%. Machado et al. (2010) found that cows with a lower BCS were more likely to be culled and had shorter longevity than cows with a higher BCS.

Cleanliness

The cleanliness of cows reflects the hygiene of their environment because when a cow goes to lie down, it selects a dry, and clean area, which helps to keep her body clean (EFSA, 2009). Additionally, dirty legs are an indicator of alleys covered with manure, and dirty udders and hindquarters reflect the dirtiness of resting areas. In this work, a high prevalence of dirty cows in the hind legs was observed (59.6%), lower in the hindquarter (44.5%), and even lower in the udder (24.3%).

Regarding the proportion of dirty cows in each of these areas (hind legs, hind quarter, and udder), Main et al. (2003) and Boyer des Roches (2012) observed on average 100% and 80.4% of cows with dirty hind legs, 17.7% and 51.5% of cows with dirty flanks/upper legs, and 20% and 26.5% of cows with dirty udders, respectively. A prevalence of 28% of cows with dirty udders was reported in Algeria (Dorbane et al., 2022). Dirty animals are a sign of inadequate housing management; therefore, cows with dirty udders were more likely to develop mastitis, and cows with dirty legs might also be at higher risk of developing lameness. Schreiner and Ruegg (2003) reported a significant association between poor udder hygiene and increased intramammary infections, and thus cows with udder scores 3 and 4 were more susceptible to disease than cows with lower scores.

Diseases and symptoms

The most common disease was mastitis (15.4%). Mastitis prevalence was higher than that reported by Hocine et al.

(2021). It had a significant influence on milk production as it appeared in our study. However, mastitis decreases milk production and might affect the BCS of cows as an association between milk production and body condition has been found. In addition, lack of hygiene during the milking process and inadequate disinfection of milking machines lead to udder infection (Gherissi et al., 2022). Other health troubles were identified including dystocia (9%), downer cow syndrome (5.5%), diarrhea (6.9%), and nasal discharge (7.5%). These prevalences showed the inadequate health condition of visited farms. The incidence of dystocia in this work has been less than reported in the USA (13.7%, Gevrekci et al., 2006). Dystocia was considered by cattle practitioners a crucial source of pain for cows (Huxley and Whay, 2006). Furthermore, Dobson et al. (2001) reported that dystocia results in delayed postpartum ovarian activity and delayed uterine involution.

Milk yield and its affecting factors

The mean daily milk production was 16.1 kg per cow. This yield is similar to that reported by Benatallah et al. (2015) in Algiers (16 l/cow/day) but slightly higher than that recorded by Ghozlane et al. (2009) in Constantine (14.9 kg/cow/day). Daily milk production in Algeria remained low compared to other developed countries, for example, 26.9 kg (2.6–59.9 kg) in the UK (Potterton et al., 2011) and 33.7 kg (25.7–40.2 kg) in Canada (King et al., 2016).

Among the welfare indicators in this survey, mastitis, severe lameness, lean cows, dystocia, and abnormal hooves were associated with milk yield. Some health disorders such as mastitis have a negative impact on the milk production of cows (Schreiner and Ruegg, 2003). In addition, dairy cows with similar genetic potential, but have a different level of lameness, may show a 10 to 20% decrease in production (Lensink and Leruste, 2012).

In the literature, several studies showed the expected decrease in milk production of cows suffering from claw problems (Gudaj et al., 2012; Montgomery et al., 2012). Claw disorders are responsible for 99% of lameness cases recorded in dairy cows (Murray et al., 1996), and lameness has been associated with a reduced productivity (Bicalho et al., 2008).

According to Gillespie et al. (2009), cows in zero-grazing systems produce more milk per lactation than cows with access to pasture. During the grazing season, cows may need supplementary indoor feeding to balance their diet and to give them extra energy (EFSA, 2009). Negative energy balance can also increase the risk of diseases such as ketosis, diarrhea, and locomotive problems (Collard et al., 2000). These in turn can adversely affect milk production (Bareille et al., 2003). Drop in milk production of primiparous cows is explained by the energy deficit that persists in the first 60 days of lactation (Merdaci and Chemmam, 2016).

In the present study, there was an effect of dystocia on milk yield, which corroborated with previous results highlighting that cows that had a difficulty at calving produced a lower volume of milk and were more likely to be culled (Roche et al., 2023).

Conclusion

The results of the present survey allow us to rank welfare problems; thinness, lameness, and mastitis seem to be the most problematic ahead of injuries, dystocia, and cleanliness. An effective control plan should be developed based on these major issues. This work displayed that dairy cattle husbandry needs improvement to provide better comfort and reduce lameness, thinness, and diseases. The study concluded that several health factors were linked to the milk yields of dairy cows. Furthermore, an association between a decrease in milk production and a higher incidence of health disorders would motivate dairy farmers to improve the living environment of the animals. In addition, routine veterinary examinations could help diagnose illnesses at an early stage and thus speed recovery, reduce suffering, and decrease treatment costs.

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Author contribution AAK and LM contributed to the study conception and design. AAK collected and analyzed data and prepared initial draft of manuscript. LA, DS, and DEG reviewed and edited the manuscript. All authors read and approved the final manuscript.

Data availability The datasets generated are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate Formal consent or ethics approval was not required for this study.

Conflict of interest The authors declare no competing interests.

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